AD/A-000 929

SIX COLOR INFRARED PHOTOMETER

James R. Houck, et al

Cornell University

Prepared for:

Defense Advanced Research Projects Agency
Air Force Cambrdige Research Laboratory

31 July 1972

ARPA Order No. 1366
Program Code No. OE50
Contractor: Cornell University
Effective Date of Contract: 6 November 1969

Contract No. F19628-70-C-0128
Principal Investigator and Phone No.
Dr. James R. Houck/607 256-4805
AFCRL Project Scientist and Phone No.
Stephan D. Price/617 861-2501
Contract Expiration Date: 30 June 1973

Qualified requestors may obtain additional copies from the Defense Documentation Center. All others should apply to the National Technical Information Service.

Unclassified

Security Classification

AD/A 000 929

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

Cornell University
Center for Radiophysics and Space Research
Space Science Building, Ithaca, New York 14850

2a. REPORT SECURITY CLASSIFICATION

Unclassified

2b. GROUP

3. REPORT TITLE

SIX COLOR INFRARED PHOTOMETER

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Scientific. Interim.

5. AUTHOR(S) (First name, middle initial, last name)

James R. Houck
Baruch T. Soifer

6. REPORT DATE

31 July 1972

7a. TOTAL NO. OF PAGES

~~11~~ 14

7b. NO. OF REFS

1

8a. CONTRACT OR GRANT NO. ARPA Order No. 1366

F19628-70-C-0128

b. PROJECT NO.

8692 n/a n/a

c.

62301D

d. n/a

9a. ORIGINATOR'S REPORT NUMBER(S)

Semi-Annual Technical R port #3

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

AFCRL-72-0613

10. DISTRIBUTION STATEMENT

A - Approved for public release; distribution unlimited

11. SUPPLEMENTARY NOTES

This research was supported by the Defense Advanced Research Projects Agency.

12. SPONSORING MILITARY ACTIVITY

Air Force Cambridge Research Labs (LP)
L. G. Hanscomb Field
Bedford, Massachusetts 01730

13. ABSTRACT

This report describes the work completed between November 16, 1971, and November 15, 1972, and is divided into three sections:

A) Flight KP 3.40,

B) Digital tape recorder,

C) Detectors for the wavelength range 5 to 40μ

(14)

DD FORM 1 NOV 65 1473

Unclassified

Security Classification

(SEE OVER)

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Infrared						
Spectroscopy						
Detectors						

AFCRL- 72-0613

SIX COLOR INFRARED PHOTOMETER

James R. Houck, Baruch T. Soifer

Center for Radiophysics and Space Research, Space Science Building
Cornell University, Ithaca, N.Y. 14850

Contract No. F19628-70-C-0128

Project No. 8692

Semiannual Technical Report No. 3

November 15, 1972

Contract Monitor: Stephan D. Price
Optical Physics Laboratory

Approved for public release; distribution unlimited.

Sponsored by
Defense Advanced Research Projects Agency
ARPA Order No. 1366

Monitored by

AIR FORCE CAMBRIDGE RESERACH LABORITORIES
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS 01730

ABSTRACT

This report describes the work completed between November 16, 1971, and November 15, 1972, and is divided into three sections:

A) Flight KP 3.40,

B) Digital tape recorder,

C) Detectors for the wavelength range 5 to 40μ.

A) <u>Flight KP 3.40</u>

Our liquid helium cooled telescope was flown on KP 3.40 on an Aerobee 170 at 00:21 MDT on 18 July 1972. The telescope again used the folded optical system as shown in Figure 1. Four scans were made along the galactic plane from to $+85^{\circ}$. The galactic latitude varied from -1° to $+1^{\circ}$. The detector sensitivites as follows:

	NEP (System)
5-6 μ	1.8×10^{-13} watts $Hz^{-1/2}$
8-14	8×10^{-15}
16-23	3×10^{-14}
80-120	1.6×10^{-13}
200-300	7×10^{-12}
300-1400	1.5×10^{-12}

The rocket performance was as follows:

Vehicle: Aerobee 170 with extra exhaust bell on the sustainer engine

Launch Time: 18 July 1972 00:21 MDT

Apogee: 215 Km

Tip Off Time: 110 sec

Tip Off Altitude: 140 Km

A premature deployment of the parachute resulted in parachute failure and severe damage to the payload on impact. Although the aspect camera was broken open, the film did reveal traces due to Jupiter. It is expected that aspect information good to $\pm$ $1/4^{\circ}$ will be obtained.

The onboard digital tape recorder (see section B) was destroyed, but the tape was recovered in good condition and will be used in the data reduction.

The preliminary analysis of the data will be presented in First Data Report.

B) Digital Tape Recorder

Because it is impossible to completely eliminate the possibility of EMI from the telemetry transmitter by making ground checks, a digital tape recorder was designed, built and flown on KP 3.40. An interlock system was arranged to interrupt the telemetry transmitter for a period of 30 seconds near apogee (ground radar was also interrupted) if the tape recorder was operating normally. All of these functions operated correctly during the flight and a post flight analysis of the tape shows no EMI. Since the tape recorder operated with an 11 bit word length, its record has 7 times greater resolution than does the TM record. Full use will be made of this increased resolution during the data analysis.

Design Philosophy

The tape system was designed to use a Computer Access Systems model 250 tape transport with biphase encoding. The data bit rate was 8K band. Provision was made to sequentially sample 16 analog input channels each in the range 0-5 volts. The analog signal was converted to an 11 bit word by an A/D converter. A digital multiplexer then scanned the output of the A/D and clocked the data to the recorder. The 11 bit data words were separated by a "1" bit. Every 1600 data words a 12 bit "0" sync. word was inserted. This sync. word also produced a fiducial on the TM event channel in order to synchronize the TM and tape records post flight.

System Performance

Digital Data Rate: 8K band

Record Length: 340 seconds

Resolution: 11 bit digital (2.5 mv analog)

Storage Capacity: 2.7×10^6 bits

Sample Rate: 40/sec/channel

Input: 0-5v 30 meg ohm

Input Offset: 2 mv Typ (-25 to +85°c)

Tape Speed: 9"/second

Power Requirement: 900 mA @ 7.5 v (supplied by 5-HR o.5)

System Description

The tape transport, voltage regulators and batteries were housed in an air tight aluminum bos (TRB), the A/D and the logic circuits were housed as a unit (SEQ), as were the analog switches (MUL). A block diagram of the system is shown in Figure 2.

Decoding Ground Station

The ground station for decoding the data in the field is shown on Figure 3. Since only "quick look" capability was desired, the system was designed to decode only one channel at a time.

Only an eight bit D/A was used for the same reason. The detailed analysis will be done with our alpha-16 computer at Cornell making use of all 11 bits.

Detailed schematics are available for the entire system MUL, SEQ, TRB, and the ground station and will be supplied on request.

C) Detectors for the Wavelength Range 5 to 40μ

Work on short wavelength detectors (5-40μ) has been primarily devoted to fabrication and testing of copper doped germanium detectors, with some time spent on the testing of zinc doped germanium detectors obtained from Santa Barbara Research Center (SBRC).

The fabrication technique used closely follows that described by T. M. Quist.[1] Germanium blocks with evaporated copper layers were baked in an 85% argon, 15% hydrogen atmosphere at 745°C for 18 hours followed by a rapid quench. Various methods of soldering indium contacts to 3 mm cubes cut from the germanium blocks were tried; no method was found to be substantially superior to any other.

The NEP's (Noise Equivalent Power) of the detectors were determined in the standard manner, using a 600°C blackbody as a reference source, and an interference filter to define the spectral response of the system (12-14 microns). All detectors were tested at 4.2°K; no attempts to test detectors at other temperatures were made. Results to date indicate the best copper

---

1) Quist, T. M., Proc. IEEE, 56, 1212 (1968).

doped detectors have NEP's of 2 x 10^{-15} watts, and responsibilities of .5-1.5 amps/watt. These detectors are essentially background photon noise limited.

Zinc doped germanium detectors supplied by SBRC were also tested to determine their NEP's. The best results to date are NEP's of 3-6x10^{-10} watts.

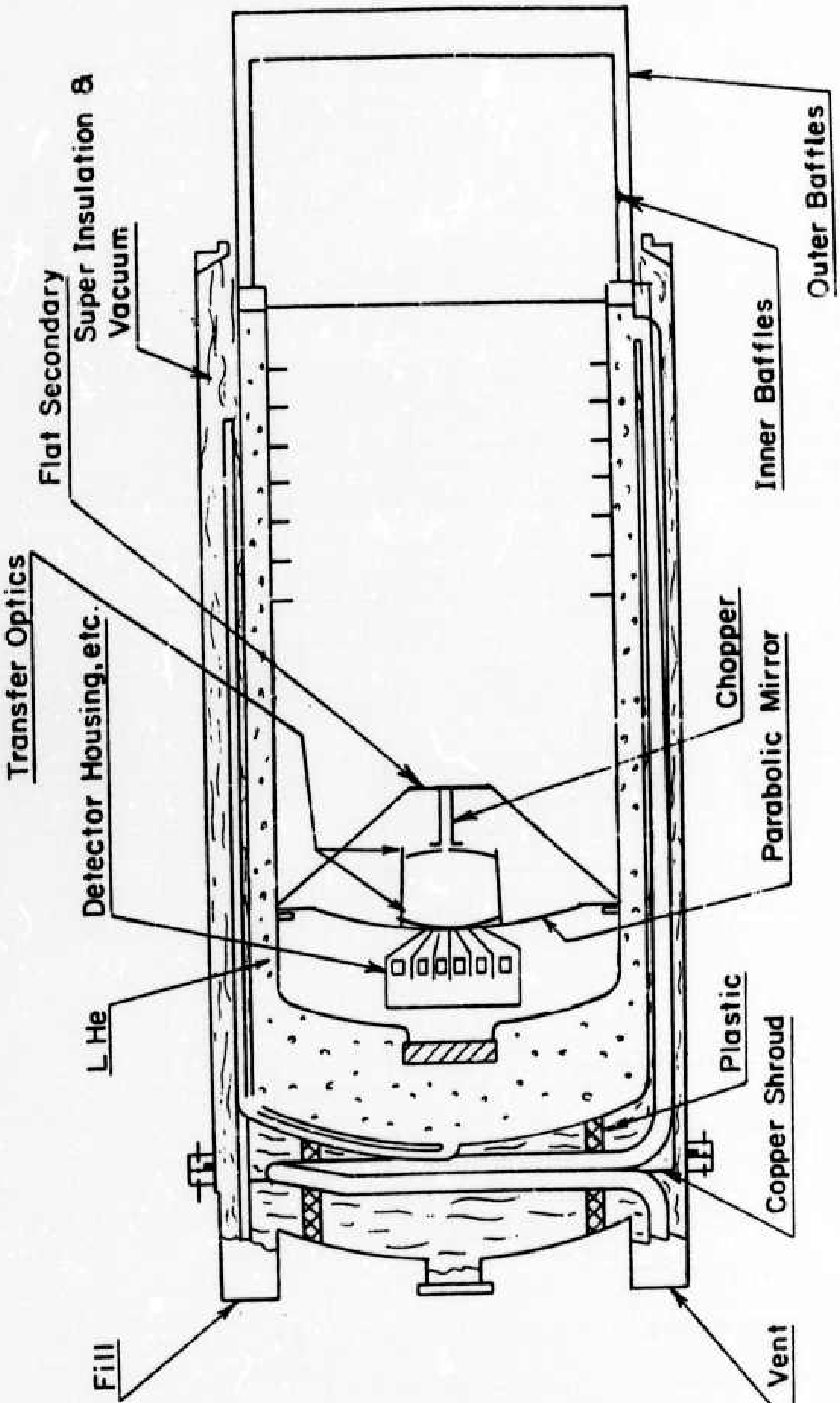
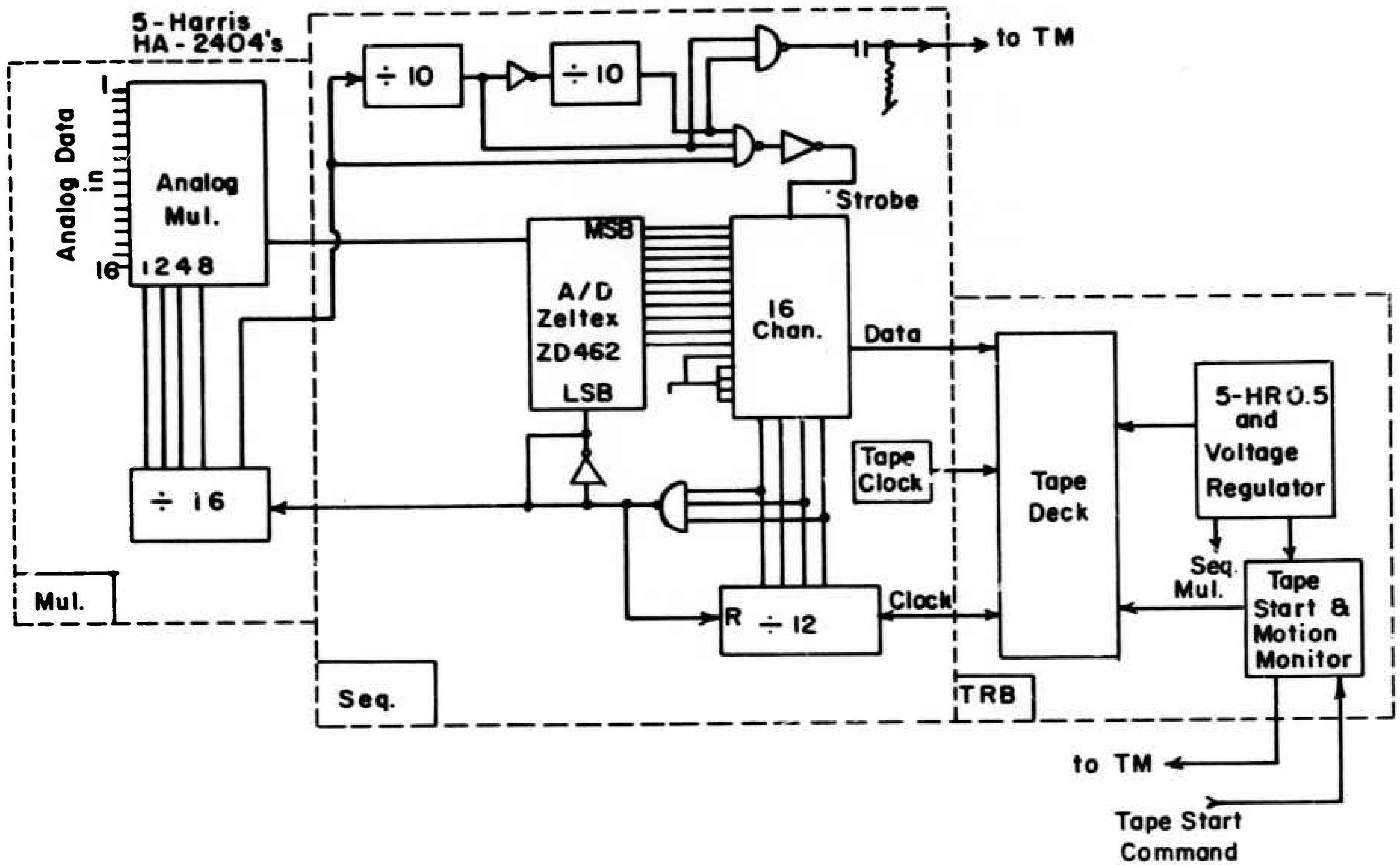
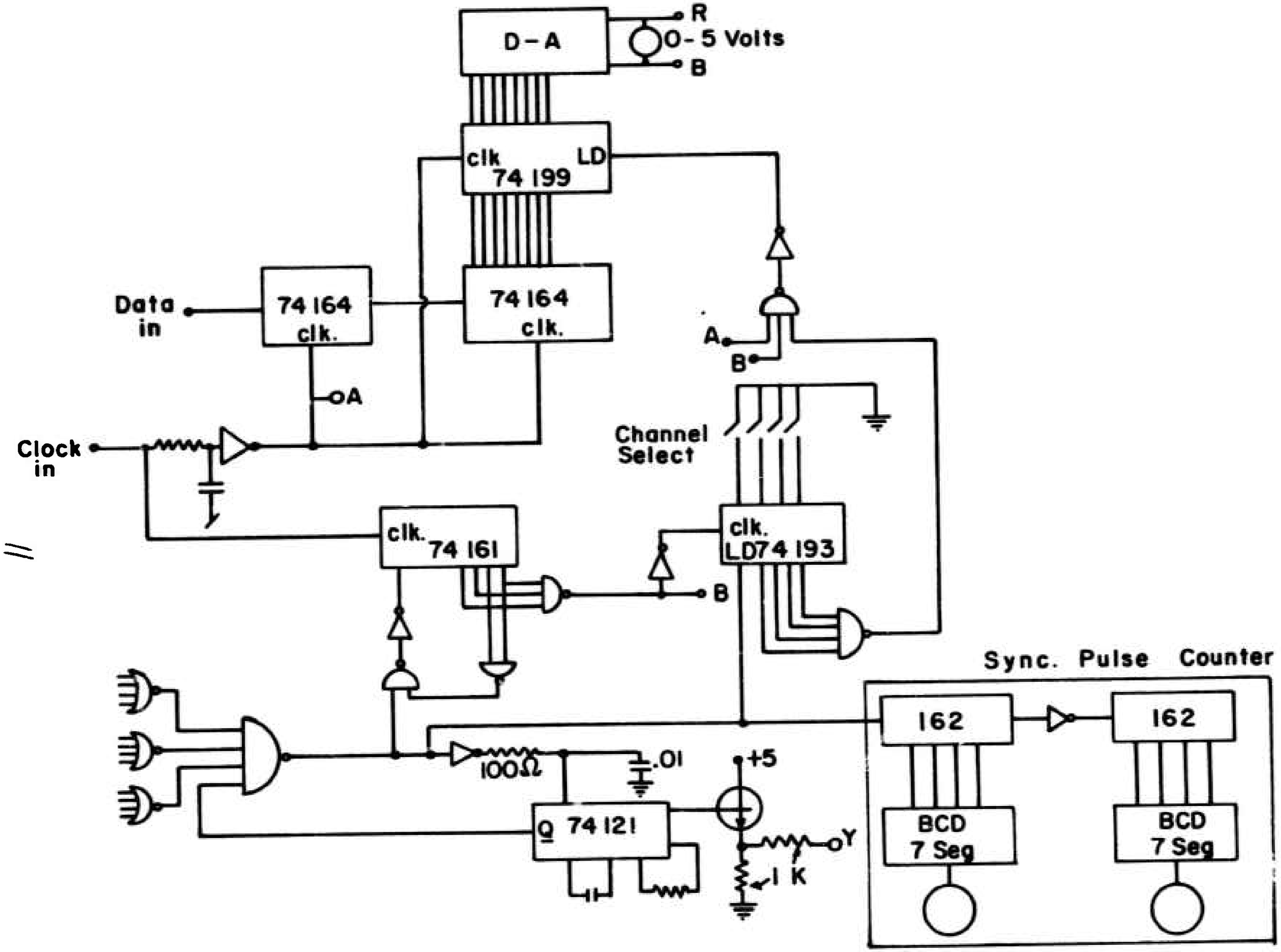

Super Insulation &
Vacuum
Flat Secondary
Transfer Optics
Detector Housing, etc.
L He
Fill
Outer Baffles
Inner Baffles
Chopper
Parabolic Mirror
Plastic
Copper Shroud
Vent

Figure I.



5-Harris HA-2404's
Analog Data in
1
16
Analog Mul.
1 2 4 8
÷ 16
Mul.
÷ 10
÷ 10
to TM
Strobe
A/D Zeltex ZD462
MSB
LSB
16 Chan.
Data
Tape Clock
R ÷ 12
Clock
Seq.
TRB
Tape Deck
5-HR 0.5 and Voltage Regulator
Seq. Mul.
Tape Start & Motion Monitor
to TM
Tape Start Command

11



D-A
R
0-5 Volts
B
clk
74 199
LD
Data in
74 164 clk.
74 164 clk.
A
Clock in
A
B
Channel Select
clk. 74 161
clk. LD74 193
B
Sync. Pulse Counter
162
162
BCD 7 Seg
BCD 7 Seg
100Ω
.01
+5
Q 74 121
Y
1 K